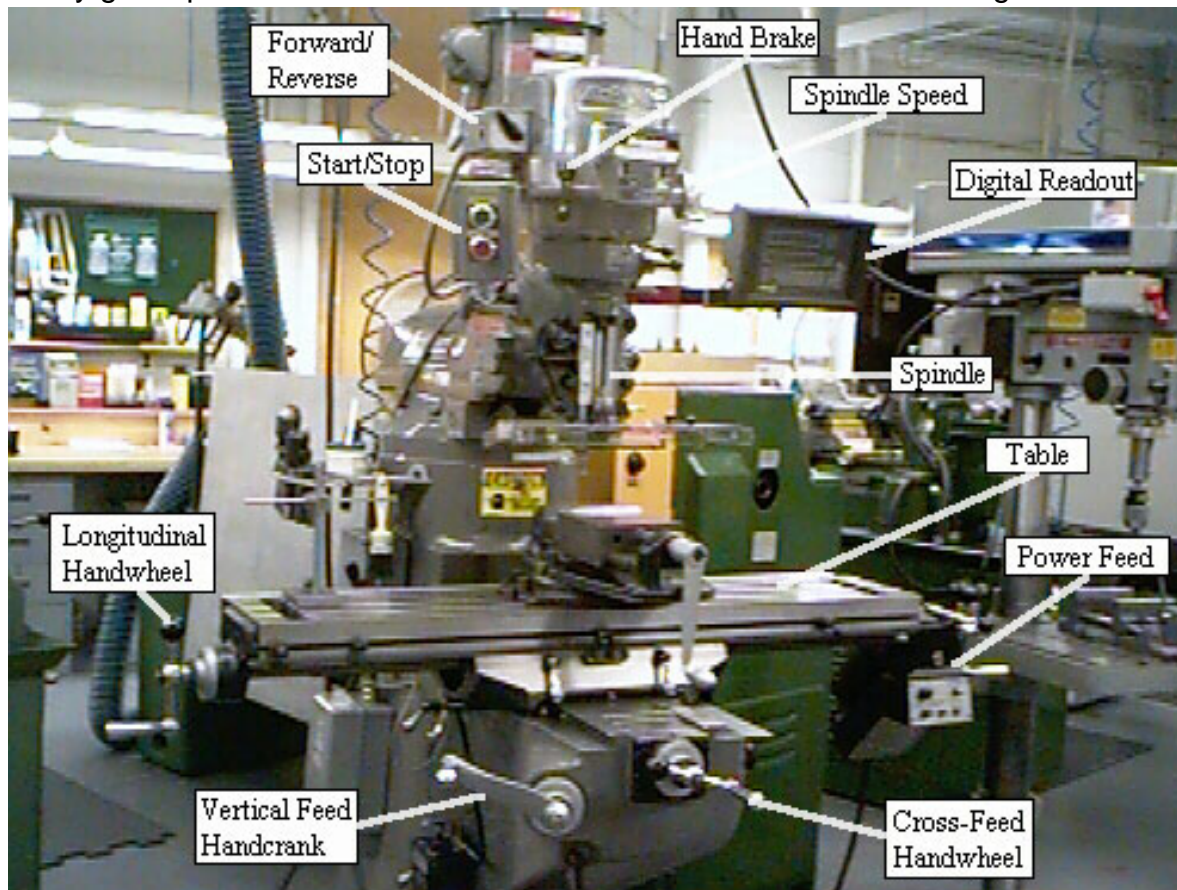


Vertical Milling Machine

This study guide will cover the major working parts, functions, and machining techniques that can be found/used on most **vertical milling machines**.

This study guide has been designed to directly represent the questions that will be found on the open book written assessment and as an aid for the hands-on usability assessment. Both assessments will also include questions related to standard machine shop safety and APS internal user safety guidelines.

Answering the questions found at the end of the study guide will enable the user to successfully pass the hands-on usability and open book written assessments. Study guide practice test and answers can be found at the end of the guide.



The Milling Machine uses a rotating milling cutter to produce machined surfaces by progressively removing material from a work piece. The vertical milling machine also can function like a drill press because the spindle is perpendicular to the table and can be lowered into the work piece.

THE CONTROLS

START/STOP

The green button starts the spindle motor and the red button shuts the motor off.



Variable Motor Drive used on some Milling Machines

FORWARD/REVERSE

This switch changes the rotation direction of the spindle. When the milling machine is in high range this switch is in the forward position for cutting but in low range the switch is in the reverse position. Putting the switch in the opposite position while remaining in the same range reverses the rotation of the spindle.

HAND BRAKE

Also known as the spindle brake, it is used to bring the spindle rotation to a stop after the power is turned off and to aid in removing collets and chucks. The spindle can be locked by pressing or pulling the brake and then pushing it up.

SPINDLE SPEED

This wheel is used to change the speed of the spindle for both high range and low range. The milling machine must be running when changing the speed.

POWER FEED

The power feed uses a motor to control the motion of the longitudinal feed in either direction at various speeds. Not all of the milling machines in the shop have this option.

CROSS-FEED HANDWHEEL

This hand-wheel moves the table in and out.

VERTICAL FEED HANDCRANK

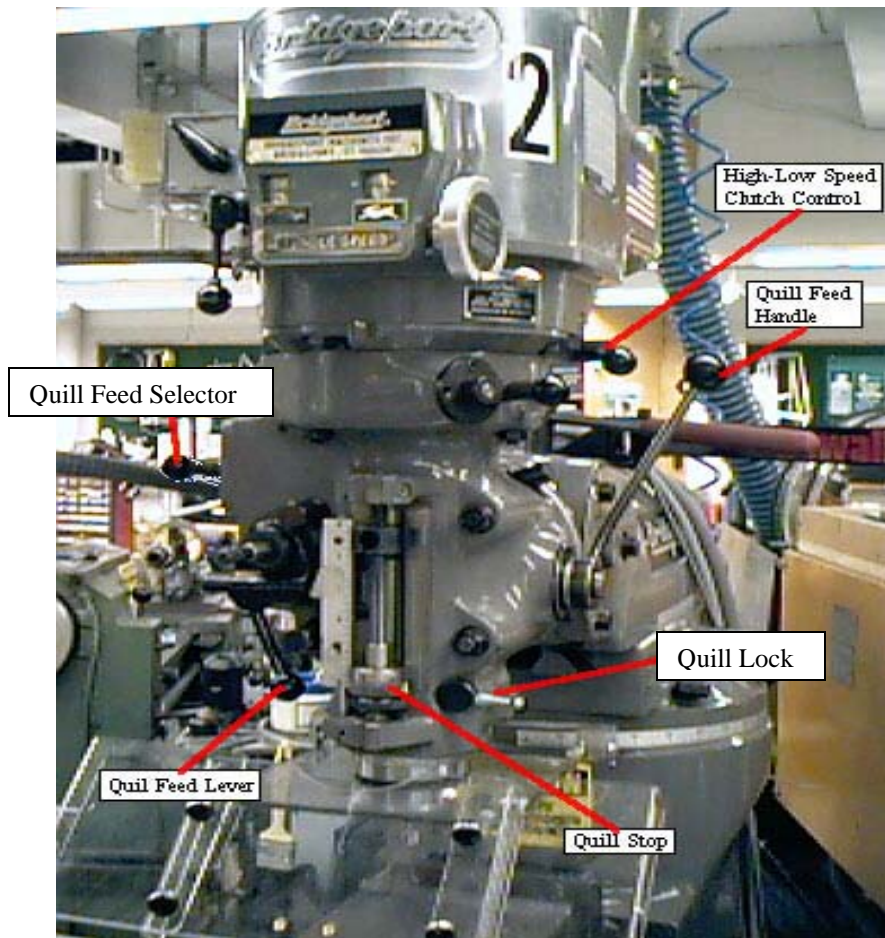
This is used to raise and lower the table.

LONGITUDINAL HANDWHEEL

This hand-wheel moves the table left and right. On some machines the handles are spring activated to keep them from rotating when the power feed is used.

HIG-LOW SPEED CONTROL

The high-low speed switch changes the range from high to low and vise-versa. The spindle may need to be turned by hand while engaging the gears.

**QUILL FEED HANDLE**

You can raise and lower the quill (spindle) with this handle.

QUILL LOCK

Pushing this lever down will lock the quill, pulling it back up releases the lock. The quill must be locked when milling.

QUILL STOP

The quill stop can be adjusted by hand to set a limit on the quill travel is also used to disengage the quill feed. This is useful when multiple holes have to be drilled to the same depth.

QUILL FEED LEVER AND SELECTOR

These are used to activate the power feed for the quill. The selector will adjust the speed of the power feed and the lever activates the drive. The quill can be Feed down into the part or up.

DIGITAL READOUT

Digital readouts (DRO) are added to the milling machines to aid in the accuracy of cuts and increase productivity. The lateral movement of the table can be measured to 2/10,000th of an inch with the readouts. Other operations the readout can perform include dividing any dimension by two, running with absolute or relative measurements, and displaying in inches or millimeters.

**LONGITUDINAL/CROSS-FEED AXIS**

The digital readout will display the distance traversed in both the X and Y-axis.

ZERO BUTTONS

These two buttons will set their respective displays to zero. This is used after the machinist finds the edge of their part and wants to reference all of the other measurements off that axis.

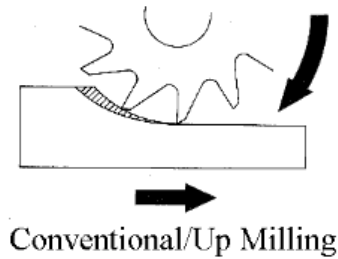
INCHES/METRIC BUTTON

The readout can give all measurements in inches or millimeters, by pressing this button it will switch from one system of measurement to the other.

KEYPAD

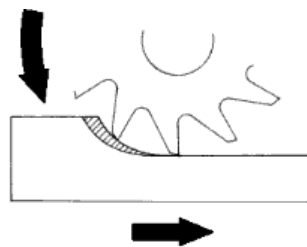
Dimensions can be entered into the readout using the keypad. This can be helpful when a reference point is needed other than zero.

Peripheral and Face Milling Techniques



Conventional/Up Milling

Fig. 1



Climb/Down Milling

Fig. 2

Peripheral milling uses teeth on the outer edge of the cutter body. The surface produced corresponds to the contour of the milling cutter, which can range from a flat surface to a formed shape.

There are two different methods of peripheral milling, Conventional or Up Milling (Fig. 1) and Climb or Down Milling (Fig. 2). The figures on the left show the rotation of the cutting tool with respect to the direction of the part on the table.

In conventional milling the work is fed against the cutter, which compensates for backlash in the table. Each tooth of the cutting tool starts its cut in clean metal, prying the material off the work.

Down milling will give a better quality of work and is better suited for thin pieces of material since the cutting action forces the work into the table. This method should not be used on hard materials and the machine has to be rigid so backlash cannot occur. The cutting tool will also last longer using Down milling as long as good tool pressure is maintained.

The machines in the shop are suitable for both types of milling. If you are unsure of which method you should use ask somebody in the shop for assistance.

Face milling uses the bottom of the mill to machine the work instead of the sides. The cutting comes from the combined action of cutting edges located on the face (or end) of the cutting tool as well as the edges on the periphery. The direction of the feed with relation to the rotation is not important when using this method.

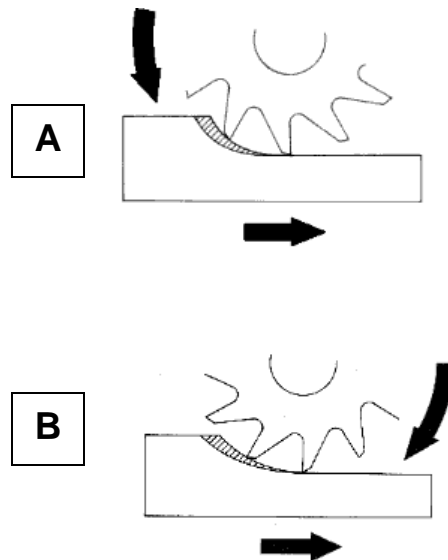
Practice Test

The following questions have been designed to directly represent the questions that will be found on the written assessment and as an aid for the hands-on usability assessment.

1. Always stop the machine before making measurements or cleaning out chips.
True False
2. Counter-boring is done to prepare a drilled hole to receive a fillister or socket-head screw.
True False
3. Machine shields should be in place before actual machining takes place.
True False
4. The inclined angle of the standard countersink used for countersinking for flat head machine screws is:
A. 82°
B. 60°
C. 90°
D. 41°
5. Always use vises or clamps to hold work pieces.
True False
6. Face milling cutters are intended for machining large flat surfaces parallel to the face of the cutter.
True False
7. Never activate the rapid traverse while the cutter is making a cut.
True False
8. Be thoroughly familiar with the placement of the machine's "stop" switch or lever.
True False
9. Climb milling should never be performed on machines _____.
A. with play in the table
B. that are not in top condition
C. not fitted with an anti-backlash device
D. All of the above
E. None of the above

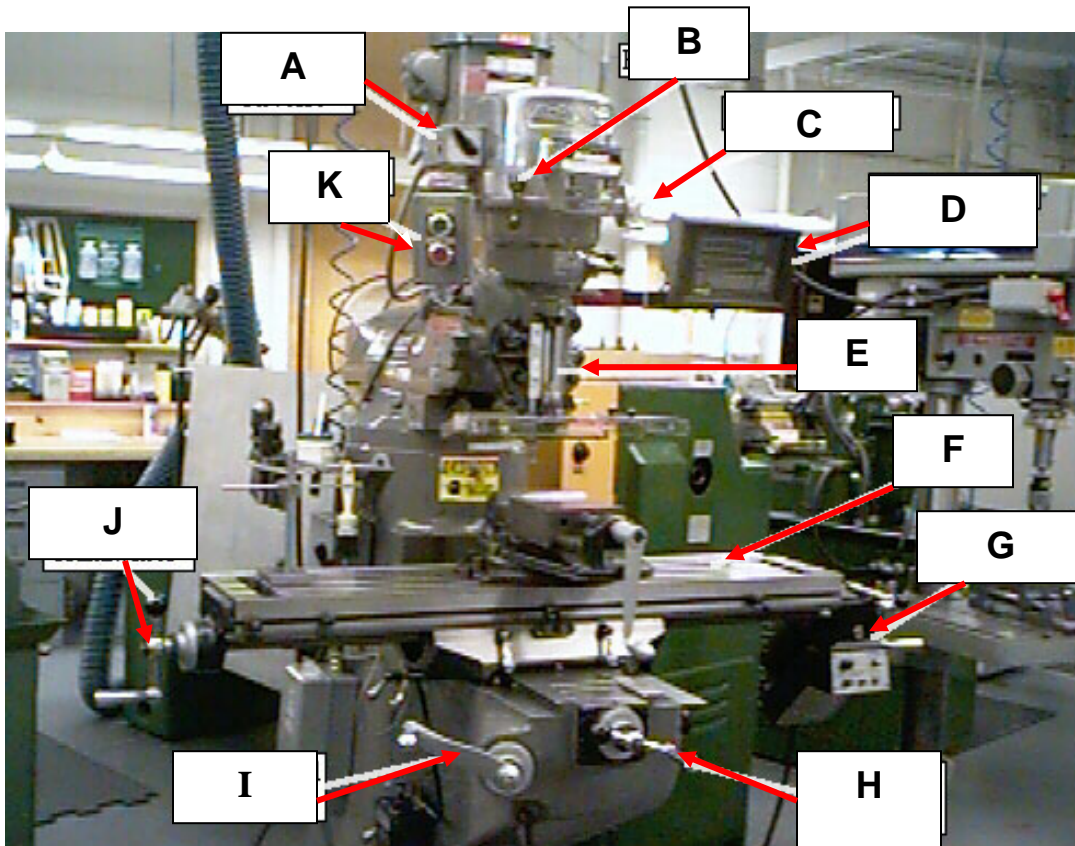
10. Stop the milling machine before _____.
 A. Attempting to make adjustments or measurements.
 B. Trying to remove accumulated chips.
 C. Before opening or removing guards and covers
 D. All of the above.
11. The milling machine is a very versatile machine tool. It can be used to _____.
 A. drill, bore, and cut gears
 B. machine flat surfaces
 C. machine irregularly shaped surfaces
 D. All of the above
 E. None of the above
12. It is permissible to leave the chuck key in the chuck while drilling a hole.
 True False
13. Machine safety guards are not required to be in place most during machining operations.
 True False
14. Always keep hands at a safe distance from moving machine parts.
 True False
15. In conventional milling the work is fed against the cutter.
 True False

16. Which of the pictures portrays
 Conventional cutting method?
- _____



Identify the parts of a Vertical Milling Machine.

17. _____ Start/Stop Button
18. _____ Digital Readout
19. _____ Longitudinal Hand Wheel
20. _____ Power Feed
21. _____ Forward/Reverse Switch
22. _____ Spindle
23. _____ Table
24. _____ Hand Brake
25. _____ Cross-Feed Hand Wheel
26. _____ Spindle Speed
27. _____ Vertical Feed Hand-crank



28. Never wear jewelry or loose clothing while operating machine

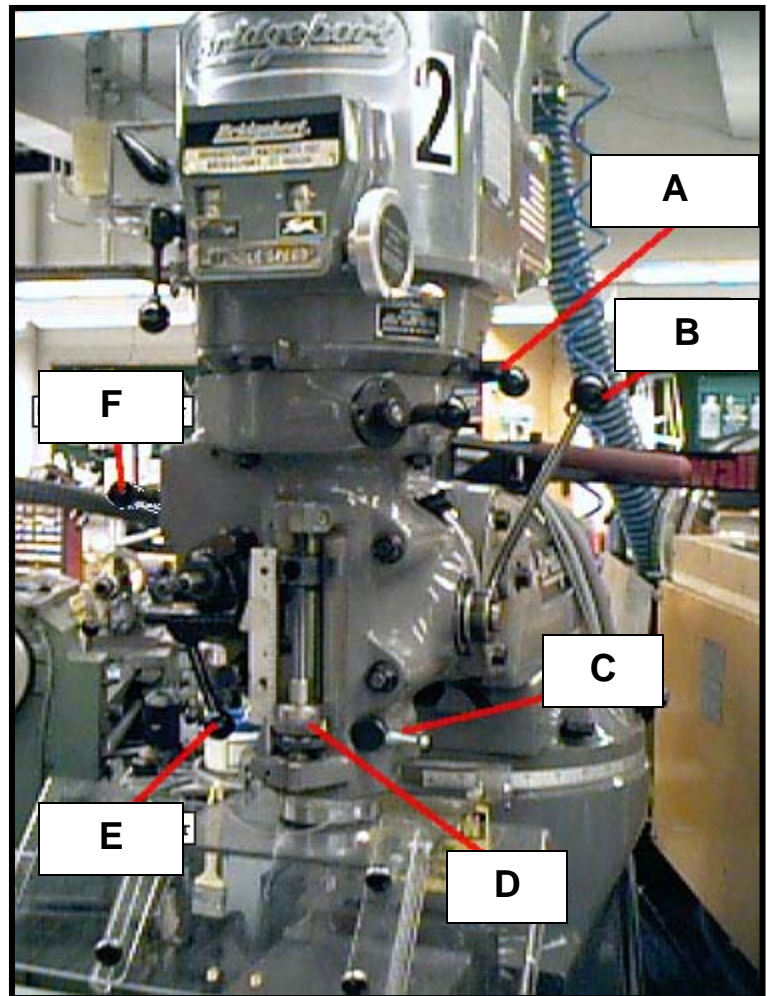
True False

29. Machine safety guards are not required to be in place during machining operations.

True False

Identify the parts of a Vertical Milling Machine Head

- 30. _____ Quill Feed Lever
- 31. _____ Quill Stop
- 32. _____ High/Low Speed Control
- 33. _____ Quill Feed Handle
- 34. _____ Quill Lock
- 35. _____ Quill Feed Selector



Study Guide**Answer Sheet**

- | | |
|-----------|-----------|
| 1. True | 19. J |
| 2. True | 20. G |
| 3. True | 21. A |
| 4. A | 22. E |
| 5. True | 23. F |
| 6. True | 24. B |
| 7. True | 25. H |
| 8. True | 26. C |
| 9. D | 27. I |
| 10. D | 28. True |
| 11. D | 29. False |
| 12. False | 30. E |
| 13. False | 31. D |
| 14. True | 32. A |
| 15. True | 33. B |
| 16. B | 34. C |
| 17. K | 35. F |
| 18. D | |